#### IN THE UNITED STATES COURT OF FEDERAL CLAIMS

DEMODULATION, INC.

V.

No.: 1:11-CV-236-SGB

THE UNITED STATES

Judge Susan G. Braden

OF AMERICA

#### FIRST AMENDED COMPLAINT

1. Demodulation, Inc. ("Demodulation") is a corporation formed under the laws of the State of Delaware, with its principle place of business at 121 Goodwin Terrace, Westwood, New Jersey.

2. This Complaint makes allegations that the federal government breached contracts with Demodulation, misappropriated Demodulation's patented technology and trade secrets and infringed patents held by Demodulation.

3. Jurisdiction is conferred upon the United States Court of Federal Claims by 28 U.S.C. § 1491, and 28 U.S.C. § 1498.

4. On Easter Sunday, 2005, Roger Lewis of the National Nuclear Security Administration ("NNSA") called the CEO of Demodulation at his home and expressed the government's intense interest in acquiring Demodulation's patented and proprietary technology, intellectual property and other trade secrets.

5. The NNSA is a department of the United States Department of Energy ("DOE") and is responsible for the operation of several federal facilities including Sandia National Laboratory ("Sandia") in Albuquerque, New Mexico and the Y-12 National Security Complex ("Y-12") near Oak Ridge, Tennessee. The NNSA is charged with ensuring the security of the United States

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"by maintaining the safety, security, and effectiveness of the U.S. nuclear weapons stockpile without nuclear testing; reducing the global danger from the proliferation of nuclear weapons and materials; providing the U.S. Navy with safe and effective nuclear propulsion; and providing the Nation with an effective nuclear counterterrorism and incident response capability."

- 6. Sandia is managed and operated by Lockheed Martin Corporation.
- 7. Y-12 is managed and operated by BWXT Y-12, LLC ("BWXT"). All of BWXT's actions and inactions alleged herein are alleged to have occurred in the course of BWXT's operation of Y-12. Accordingly, all of BWXT's actions and inactions alleged herein are the legal responsibility of the government.
- 8. After receiving Roger Lewis' invitation to present its technology to the government, Demodulation executed two confidentiality agreements with the NNSA whereby NNSA agreed it would not "disclose, publish or otherwise reveal any of the Confidential Information received from Demodulation to any other party whatsoever." See Exhibits A and B.
- 9. Pursuant to the confidentiality agreements, Demodulation disclosed proprietary information concerning its technology to NNSA and BWXT. Among the disclosures made was a presentation given in December 2005 by Demodulation at a wireless technologies workshop at the DOE's facility in Germantown, Maryland.
- 10. At all times from Easter of 2005 forward, Mr. Lewis and other NNSA and BWXT personnel told Demodulation that the purpose of Demodulation's disclosure of information was for Demodulation to obtain a contract to provide its technology and intellectual property to the United States government in exchange for payment to Demodulation and to help Demodulation commercialize its technology for sale to others.

- 11. Mr. Lewis and other NNSA personnel told Demodulation that there were a broad array of disruptive applications for Demodulation's technology and intellectual property within the government market including homeland security, intelligence, defense, logistics and anti-counterfeiting applications.
  - 12. In 2006, NNSA personnel directed Demodulation to a potential opportunity at Y-12.
- 13. On or about February 12, 2007, Demodulation entered a written Cooperative Research and Development Agreement ("CRADA") with the DOE. See Exhibit C.
- 14. DOE induced Demodulation to enter the CRADA with promises to assist Demodulation in commercializing its technology, by recognizing the validity of Demodulation's patents, intellectual property and trade secrets and by promising lucrative government contracts if the technology met expectations.
- 15. The terms of any CRADA, including the one at issue here, must conform to the law governing CRADAs, including but not limited to the Wydler-Stevenson Technology Transfer Innovation Act, amendments thereto, corresponding and related federal regulations, and the "Class Waiver" of the government's rights in or to any inventions and other intellectual property derived from the CRADA relationship.
- 16. The legislative purpose of a CRADA is to help private parties, like Demodulation, to commercialize government technologies that are being underutilized. Demodulation expected that the government had the same understanding of the purpose of the CRADA. However, the CRADA was used by the DOE, BWXT and others as a vehicle to wrongfully extract technology, intellectual property and trade secrets from Demodulation without having to pay for it.

- 17. Demodulation's proprietary microwire technology platform consists of an amorphous metal, glass coated wire and electronic systems to detect the wire from distances up to and beyond twenty miles.
- 18. As a general description, a one inch strand of microwire is a fraction of the width of a human hair, may be covertly embedded, and may be remotely detected without the need for a source of power connected to the wire. The microwire has applications beyond sensing capabilities, such as the ability to harvest energy from the ambient electromagnetic conditions in the atmosphere and to render objects invisible to radar. Additionally, the microwire may be engineered to transmit digital information.
- 19. Pursuant to the CRADA, DOE thoroughly vetted and characterized the microwire and its myriad applications. DOE concluded that the applications for this technology, as stated by Y-12 Section Manager L. Neville Howell, Jr., "are limited only by your imagination." Mr. Howell was one of the DOE employees or agents primarily responsible for administering the CRADA on behalf of the government.
- 20. The evaluation conducted pursuant to the CRADA concluded, among other things, that: the slightest tension on the microwire alters the response from the microwire making it suitable for "temperature, pressure, chemical and biological sensing;" the microwire's response is altered by its angular relation to an alternating magnetic field making it suitable for a "pitch, yaw and roll" sensor; a break in the microwire can be detected making it suitable for tamper indication; the microwire can detect tension when deployed in nonferrous material; "[m]icrowires appear to have unique signatures, similar to differences among fingerprints or snowflakes. These signatures can be modified by incorporating minute magnetic material at different locations along the length of the microwire. In addition, if localized stress variations along the length are

incorporated, these, too, change the signature. This experiment validated the belief that an encoding method is feasible and supports Demodulation's encoding patents. The unique signature and/or ability for encoding could have many benefits, including a defense for counterfeiting;" the microwire was superior to magnetic strips found on credit cards and other items because microwire is practically invisible and never wears out, unlike the magnetic strips; the microwire was an "excellent candidate" for *in-situ* sensors and there is a robust market with "few competing products;" the microwire was well suited for detection of "gas, pressure, temperature, humidity;" if microwire were attached to a seal, a broken seal would be identified; the glass coating on a microwire may be "coated with a substance that will react when attacked by a chemical or biological agent;"

- 21. In addition to the conclusions reached by DOE recited above, DOE conducted additional research and reached additional conclusions concerning microwire which are contained in a report which DOE has denoted as "classified" and has refused to provide to Demodulation.
  - 22. The CRADA expired on or about February 12, 2009.
- 23. Two days prior to the expiration of the CRADA, Mr. Howell wrote to Demodulation: "I have stated this many times to my guys and to my senior managers It will be disappointing for us (Y-12) to develop this application and then have to deal with an enormous license fee that would shoot the practicality of the application out of the water. I guess we will just deal with that issue at the appropriate time."
- 24. On Monday March 2, 2009, Mr. Howell wrote to Demodulation that there was "a small sub-contract in FY10 for you (and Wes if available) providing consulting services to us on a feasibility project. I'm thinking 20 employee-days at \$1,000 per employee-day plus travel and per diem expenses. The not-to-exceed total would be \$30K. The microwire used in the

feasibility study would NOT be consumed. The detection system will be RF. I can share with you most of the details the next time I see you. Are you interested? If so, I need a reply. The proposal is due Wednesday and our chances of winning are at least 90%. This will keep us going one more year."

- 25. In the fall of 2008, after DOE reached the conclusions in Paragraph 8 above, representatives of Demodulation met with Mr. Bud Albright, Under Secretary of Energy, to finally disclose the "subject inventions" developed pursuant to the CRADA and to discuss the federal government's purchase or license of Demodulation's technology, intellectual property and various applications. At this meeting, Mr. Albright stated that there was "no applications" for Demodulation's technology. In a prior meeting between Mr. Albright and Demodulation personnel, Mr. Albright had stated that there were numerous applications for the technology throughout the federal government.
- 26. After the expiration of the CRADA, DOE and other branches of the federal government engaged in continuing development of applications for Demodulation's technology. For example, on March 1, 2009, the federal government gave a grant to Thermal Solutions, Inc. for the development of a temperature sensing system comprised of a wireless reader capable of remote interrogation of amorphous microwire temperature sensors.
- 27. During the course of the CRADA, Demodulation disclosed proprietary information and trade secrets to DOE concerning its microwire technology. The disclosed information related to, without limitation, the composition of the wire, the method for making the wire and variations in its chemistry, means for detecting the wire and proprietary signal processing technology.
- 28. During the course of the CRADA and after, DOE disclosed Demodulation's proprietary information and trade secrets to one or more third parties without the permission of

Demodulation. The disclosures include but are not limited to the one DOE made to "another part of the government" in connection with a DOE proposal to get a fulfillment contract with "another part of the government" and the "classified" information DOE provided to Mentai Fong of the Intelligence Advanced Research Projects Agency ("IARPA").

- 29. DOE also disclosed Demodulation's proprietary information to Zach Nienstedt, a graduate student at the North Carolina State University. After this disclosure was made, Mr. Nienstedt engaged in research concerning the proprietary information sponsored by North Carolina State University.
- 30. DOE violated its non-disclosure obligations by disclosing Demodulation's confidential information to Cubic Corporation. Cubic Corporation later passed off the information as its own while presenting the information to Raytheon. Cubic presented Raytheon with proposals for classified and non-classified applications including but not limited to tracking, anti-counterfeiting, tamper indication, space, homeland security, military, and long range detection between an aircraft and the ground.
- 31. DOE violated its non-disclosure obligations by providing Demodulation's intellectual property and trade secrets to Sekuworks for anti-tamper and anti-counterfeiting applications.
- 32. After the expiration of the CRADA, DOE received and/or provided funding in the year 2010 for production of a product or system that included the use of microwire and Demodulation's intellectual property and trade secrets.
- 33. DOE was obligated to disclose to Demodulation any "subject inventions" that arose from the research and development performed under the CRADA. Despite the overwhelmingly positive results of DOE's evaluation and its several statements that it was working on developing inventions through 2010, DOE has not disclosed any subject inventions to Demodulation.

- 34. Y-12 issued a "Final Report" concerning the CRADA. <u>See</u> Exhibit D. The first sentence of the Final Report states the "report was prepared as an account of work sponsored by an agency of the United States government."
- 35. Despite DOE's failure to disclose any inventions, DOE and other branches of the federal government continue to use microwire in various applications. Evidence of these applications include but is not limited to the following: The United States Army is using microwire and Demodulation's trade secrets in its mission to gather intelligence and track friendly soldiers through the Aerial Common Sensor program and other similar program programs; Frank Downs of the Naval Surface Warfare Center in Panama City, Florida, stated that Demodulation's technology has been deployed in operations and that the government has obtained a detection range of at least twenty miles; in 2009, Dr. Steven Wax stated that the Defense Advanced Research Projects Agency ("DARPA") had been working on microwire for a long time, that the government had a right to take Demodulation's technology and that Demodulation would have to "catch us if you can;" Dr. Toni Marechaux stated that Sandia was developing microwire technology; representatives of Lockheed Martin advised Demodulation that the government had detected microwire from an Unmanned Aerial Vehicle using dual tone frequency radar; Rick Ward of the Appleton Paper Company advised Demodulation that the government had established a secure facility for the production of microwire; Chuck Loomis, formerly of Naval Intelligence and formerly of Science Applications International Corporation, informed Demodulation that microwire technology is being deployed by the government.
- 36. On January 26, 2010, Demodulation filed with DOE a formal request for dispute resolution pursuant to 10 C.F.R. §782. DOE accepted and acknowledged the request, but has not otherwise responded.

#### **COUNT ONE**

#### Breach of Express Contract – Tucker Act, 28 U.S.C. 1491

- 37. Demodulation incorporates each of the foregoing paragraphs of the complaint as if each were set forth at length herein.
- 38. Three express contracts were entered into between Demodulation and the government, as described above.
- 39. The government breached the confidentiality obligations of these agreements by disclosing confidential information to one or more third parties including but not limited to the National Security Agency ("NSA"), the persons who were present at or who otherwise received the information presented at the "Innovation Colloquium" presented by Chuck Agle, Jr. and those parties mentioned elsewhere in this complaint.
- 40. The CRADA must be interpreted and enforced in accord with the law governing CRADAs. For example, Article XXVIII of the CRADA must be stricken from the CRADA because only the Unites States Court of Federal Claims has jurisdiction over contract claims brought against the government.
- 41. DOE breached the terms of the CRADA and the implied covenant of good faith and fair dealing by spending federal funds to obtain a supply of Demodulation's microwire and Demodulation's intellectual property and trade secrets.
- 42. DOE breached the terms of the CRADA and the implied covenant of good faith and fair dealing by failing to disclose any subject inventions to Demodulation though the government has in fact deployed Demodulation's technology, intellectual property and trade secrets in various applications and has otherwise become aware of subject inventions.

- 43. DOE breached the terms of the CRADA and the implied covenant of good faith and fair dealing by disclosing Demodulation's confidential information to one or more third parties including but not limited to those disclosures mentioned elsewhere herein and the disclosure made by Bill Barrett of Y-12 to the United States Army.
- 44. DOE breached the terms of the CRADA and the implied covenant of good faith and fair dealing by failing to perform the obligations which it and its agents agreed to perform under the contract and by performing research not permitted under the CRADA.
- 45. DOE, through Y-12, breached the terms of the CRADA and the implied covenant of good faith and fair dealing by entering into a contract with the Joint Improvised Explosive Device Defeat Organization ("JIEDDO") for the application of microwire to JIEDDO's mission.
- 46. DOE breached the CRADA and the implied covenant of good faith and fair dealing by taking or failing to take the actions described herein and by misrepresenting to Demodulation that there was no government or military applications for Demodulation's technology.
- 47. DOE breached the CRADA and the implied covenant of good faith and fair dealing by failing to assist Demodulation in commercializing its technology and by in fact taking actions to prevent Demodulation from doing so.
- 48. DOE breached the terms of the CRADA and the implied covenant of good faith and fair dealing by failing to disclose the use of microwire by other branches of the federal government.
- 49. DOE otherwise breached the terms of the CRADA by not performing the obligations described therein and imposed by the covenant of good faith and fair dealing.
- 50. As a direct and proximate result of the government's breach of contract, the government has irreparably harmed Demodulation and caused severe financial damage to Demodulation. By way of example and not limitation, but for the government's breach of contract, Demodulation

would have obtained a licensing fee from the government and would have developed and sold commercial applications for microwire.

WHEREFORE, Plaintiff demands judgment in favor of Plaintiff for monetary damages against the United States in an amount not less than Fifty Million Dollars (\$50,000,000) and to further award Plaintiff all costs, interest, fees, expenses and attorneys' fees as allowed by the Equal Access to Justice Act and other applicable law, and such other and further relief as the Court may deem appropriate.

#### **COUNT TWO**

#### Breach of Implied in Fact Contract - Tucker Act, 28 U.S.C. 1491

- 51. Demodulation incorporates each of the foregoing paragraphs of the complaint as if each were set forth at length herein.
- 52. An implied in fact contract was created when Demodulation revealed trade secrets to the government thereby imposing on the government an obligation to maintain the confidentiality of Demodulation's trade secrets and to refrain from using the trade secrets for the government's benefit without providing compensation to Demodulation.
- 53. The government breached this contract by failing to maintain Demodulation's trade secrets in confidence and by in fact utilizing those trade secrets to deploy Demodulation's technology in government applications.
- 54. As a direct and proximate result of the government's breach of contract, the government has irreparably harmed Demodulation and caused severe financial damage to Demodulation.

WHEREFORE, Plaintiff demands judgment in favor of Plaintiff for monetary damages against the United States in an amount not less than Fifty Million Dollars (\$50,000,000) and to further award Plaintiff all costs, interest, fees, expenses and attorneys' fees as allowed by the

Equal Access to Justice Act and other applicable law, and such other and further relief as the Court may deem appropriate.

#### **COUNT THREE**

#### Patent Infringement – 28 U.S.C. §1498

55. Demodulation incorporates each of the foregoing paragraphs of the complaint as if each were set forth at length herein.

56. As recognized by the DOE pursuant to the CRADA, Demodulation obtained numerous valid patents covering the manufacture, detection and manipulation of microwire. While Demodulation held these patents, including through the present, the United States used and manufactured inventions covered by these patents without a license from Demodulation. Due to the wrongful acts of the Defendant and others, Demodulation has not been able to pay the required registration fees required by the United States Patent and Trademark Office. Those patents for which such fees have not been paid were infringed during the period while the fees had been paid.

57. The patents at issue are: US 6,270,591 B2 - Amorphous and Nanocrystalline Glass-Covered Wires; US 5,557,085 - Method and device for electronic identification; US 5,576,693 - Method and device for remote sensing of objects; US 6,018,297 - Method and device for coding electronic labels; US 6,137,411 - Article surveillance system; US 6,225,905 - Sensor for remote detection of objects; US 6,232,879 - Sensor and method for remote detection of objects; US 6,417,771 - Sensor, a method and a system for remote detection of objects; US 7,075,439 - Marker for remote detection of articles; US 7,071,417 B2 - Optically Encoded Glass-Coated Microwire; US 7,233,249 - Multi-Bit Encoded Glass-Coated Microwire and Articles Composed

Thereof; US 7,354,645 - Engineered Glasses for Metallic Glass-Coated Wire; US 7,368,166 - Polymerase Chain Reaction Using Metallic Glass-Coated Microwire.

- 58. These patents have been infringed by the United States and by others acting for the United States including but not limited to Thermal Solutions, Inc.
- 59. The United States Army has infringed one or more of these patents by putting out a request for proposal to develop a system associated with the Army's program to track friendly soldiers on the battlefield using "μ-fiber microwire." This request for proposal was issued in 2008 through the Army's small business innovation research ("SBIR") program under request number A08-087. This request indicates that the Army was and is running a program using technology that infringed one or more of the subject patents.
- 60. The United States Navy has infringed one or more of the patents by utilizing technology at the Navy's Underwater Warfare Center in Newport, Rhode Island and other Navy locations including but not limited to the Navy's Carderock facility where Art Clark, a Navy employee or sailor, obtained a patent with Ikea Corporation as a result of work done for the Navy or in the name of the Navy. This patent was later obtained by Demodulation because it concerned the detection of microwire.
- 61. All of the uses alleged in Paragraph 35 above are herein incorporated by reference and are alleged to be infringing uses by the United States.
- 62. The Department of Homeland Security infringed the patents by running a program to track luggage employing infringing products at Logan International Airport in or near Boston.
- 63. Several persons currently or formerly employed by the United States Military or Intelligence Community have indicated that the government is engaged in pervasive, classified, infringing uses of microwire. Therefore, Demodulation alleges that the government is engaged in other infringing uses of which Demodulation is not specifically aware at this time.

64. As a direct and proximate result of the government's patent infringement, the government has irreparably harmed Demodulation and caused severe financial damage to Demodulation.

WHEREFORE, Plaintiff demands judgment in favor of Plaintiff for monetary damages against the United States in an amount not less than Fifty Million Dollars (\$50,000,000) and to further award Plaintiff all costs, interest, fees, expenses and attorneys' fees as allowed by the Equal Access to Justice Act and other applicable law, and such other and further relief as the Court may deem appropriate including but not limited to invalidation of any patents held by the United States or others which conflict with Plaintiff's patents and reinstatement of any patents that have expired due to the non-payment of registration fees.

#### **COUNT FOUR**

#### Violation of the Fifth Amendment

- 65. Demodulation incorporates each of the foregoing paragraphs of the complaint as if each were set forth at length herein.
- 66. The United States' misappropriation of trade secrets and other property described above and its infringement of Demodulation's patents constitutes a violation of the Constitutional guarantees of substantive and procedural due process provided by the Fifth Amendment and elsewhere in the Constitution. These actions also constitute a taking by the government for which Demodulation is entitled to just compensation.
- 67. At the suggestion of personnel from the Abraxas Corporation, Demodulation presented its technology to the Central Intelligence Agency. The CIA indicated interest in acquiring the technology and informed Demodulation that it must negotiate an acquisition contract through In-Q-Tel and only upon In-Q-Tel's approval.

- 68. In-Q-Tel is an instrumentality of the United States Government and is operated with federal funds pursuant to a charter between the CIA and In-Q-Tel.
- 69. In-Q-Tel is in the business of brokering acquisition contracts between companies and individuals possessing technology one the one hand and the CIA and other government intelligence groups on the other.
- 70. In Q-Tel is also in the business of acquiring equity stakes in technology companies including but not limited to Nanosys Incorporated and Qynergy Corporation in exchange for the investment of federal funds in the companies.
- 71. At the direction of the CIA, Demodulation presented its technology to in-Q-Tel for its consideration whether to acquire microwire for the government.
- 72. In-Q-Tel declined to either acquire Demodulation's technology for the government or to invest in Demodulation.
- 73. In-Q-Tel rejected Demodulation without due process of law and in violation of laws governing the government's acquisition of property.
- 74. As a direct and proximate result of the government's violation of Demodulation's constitutional rights, the government has irreparably harmed Demodulation and caused severe financial damage to Demodulation.

WHEREFORE, Plaintiff demands judgment in favor of Plaintiff for monetary damages against the United States in an amount not less than Fifty Million Dollars (\$50,000,000) and to further award Plaintiff all costs, interest, fees, expenses and attorneys' fees as allowed by the Equal Access to Justice Act and other applicable law, and such other and further relief as the Court may deem appropriate.

**COUNT FIVE** 

**Misappropriation of Trade Secrets** 

75. Demodulation incorporates each of the foregoing paragraphs of the complaint as if each

were set forth at length herein.

76. This action for misappropriation of trade secrets involves conduct of the government

arising out of and related to the express and implied contracts between Demodulation and the

government.

77. Demodulation possessed trade secrets related to microwire.

78. The government is using or has used those trade secrets in violation of its agreement with

Demodulation and as a result of its discovery of the trade secrets by improper means.

79. As a direct and proximate result of the government's misappropriation of trade secrets,

the government has irreparably harmed Demodulation and caused severe financial damage to

Demodulation.

WHEREFORE, Plaintiff demands judgment in favor of Plaintiff for monetary damages

against the United States in an amount not less than Fifty Million Dollars (\$50,000,000) and to

further award Plaintiff all costs, interest, fees, expenses and attorneys' fees as allowed by the

Equal Access to Justice Act and other applicable law, and such other and further relief as the

Court may deem appropriate.

Dated: September 1, 2011

s/Benjamin Light

Benjamin D. Light, Esq. AROMANDO, LIGHT & CROFT, LLC

195 Fairfield Avenue - Suite 4D

West Caldwell, New Jersey 07006

973-403-9100 - phone

973-403-9110 - facsimile

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# EXHIBIT A

#### CONFIDENTIALITY AGREEMENT

This Confidentiality Agreement ("Agreement") is made and effective on the 4/5/05 by day of by and between Demodulation Inc. ("Demodulation") and ("Recipient").

1. Confidential Information.

Demodulation proposes to disclose certain of its confidential and proprietary information which is related to a glass fiber containing a metallic alloy core that is possibly amorphous in microstructure, and which can provide acoustic or magnetic signature for use in a variety of security applications (the "Confidential Information") to Recipient. Confidential Information shall include all data, technology, computer programs, specifications, manuals, business plans, software, marketing plans, financial information. and other information disclosed or submitted, orally, in writing, or by any other recording media, to Recipient by Demodulation, provided such "Confidential Information" is marked as "Confidential Information. Confidential Information disclosed orally shall be identified as such in writing within five (5) days of disclosure. Nothing herein shall require Demodulation to disclose any of its information. For the avoidance of doubt, other than the specific glass fibers mentioned hereinabove, Demodulation shall not disclose to Recipient any information deemed confidential by Demodulation relating to the composition, design, and performance characteristics of the glass fibers and coatings therefor, processes for manufacturing such fibers and applying such coatings and the ultimate use of such fibers and coatings in particular applications. For example, Demodulation shall not disclose any information deemed confidential related to telecommunications optical fiber.

2. Recipient's Obligations.

- A. Recipient agrees that the Confidential Information is to be considered confidential and proprietary to Demodulation and Recipient shall hold the same in confidence, shall not use the Confidential Information other than for the purposes of its business with Demodulation, and shall disclose it only to its officers, directors, or employees with a specific need to know. and to its contractors with a specific need to know, for similar purposes, who are subject to the obligations of 48 CFR 52.227-14(d)(2). Recipient, will not disclose, publish or otherwise reveal any of the Confidential Information received from Demodulation to any other party whatsoever, except to its contractors as specified above, except with the specific prior written authorization of Demodulation.
- B. Confidential Information furnished in recorded form shall not be duplicated by Recipient except for purposes of this Agreement. Upon the request of Demodulation, Recipient shall return all Confidential Information received in written or other recorded form, including copies, or reproductions or other recording media containing such Confidential Information, within ten (10) days of such request. At Recipient's option, any documents or other media developed by the Recipient containing Confidential Information may be destroyed by Recipient. Recipient shall provide a

written certificate to Demodulation regarding destruction within ten (10) days thereafter.

3.Term.

The obligations of Recipient herein shall be effective 5 years from the date Demodulation last discloses any Confidential Information to Recipient pursuant to this Agreement.

4. Other Information.

Recipient shall have no obligation under this Agreement with respect to Confidential Information which is or becomes publicly available without breach of this Agreement by Recipient; is or was rightfully received by Recipient without obligations of confidentiality; or is or was developed by Recipient without breach of this Agreement.

5. Governing Law and Equitable Relief.

This Agreement shall be governed and construed in accordance with the laws of a court of competent jurisdiction.

6. Final Agreement.

This Agreement terminates and supersedes all prior understanding or agreements on the subject matter hereof. This Agreement may be modified only by a further writing that is duly executed by both parties.

7. No Assignment.

Recipient may not assign this Agreement or any interest herein, without Demodulation's express prior written consent.

8. Severability.

If any term of this Agreement is held by a court of competent jurisdiction to be invalid or unenforceable, then this Agreement, including all of the remaining terms, will remain in full force and effect as if such invalid or unenforceable terms had never been included.

9. Notices.

Any notice required by this Agreement or given in connection with it, shall be in writing and shall be given to the appropriate party by personal delivery or by certified mail, postage prepaid, or recognized overnight delivery services.

If to Demodulation:

Demodulation Inc. James E. O'Keefe, Jr. 121 Goodwin Terrace Westwood, NJ 07675

If to Recipient:

Insert Contractor Name National Nuclear Security Administration Contractor Address

10. No Implied Waiver.

Either party's failure to insist in any one or more instances upon strict performance by the other party of any of the terms of this Agreement shall not be construed as a waiver of any continuing or subsequent failure to perform or delay in performance of any term hereof.

11. Headings.

Headings used in this Agreement are provided for convenience only and shall not be used to construe meaning or intent.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date first above written.

Insert Contractor Name here	DEMODULATION INC.
By: Leven D. Sivils  2-Dule Sis	By:  James E. O'Keefe, Jr.
Title: Sprior Science + Technolosy Advisor	Title: President & CEO
Date: 6-17-05	Date:

# EXHIBIT B

#### CONFIDENTIALITY AGREEMENT

This Confidentiality Agreement ("Agreement") is made and effective on the 4/5/05 by day of \_\_\_\_\_, by and between Demodulation Inc. ("Demodulation") and \_\_\_\_\_\_ ("Recipient").

#### 1. Confidential Information.

Demodulation proposes to disclose certain of its confidential and proprietary information which is related to a glass fiber containing a metallic alloy core that is possibly amorphous in microstructure, and which can provide acoustic or magnetic signature for use in a variety of security applications (the "Confidential Information") to Recipient. Confidential Information shall include all data, technology, computer programs, specifications, manuals, business plans, software, marketing plans, financial information. and other information disclosed or submitted, orally, in writing, or by any other recording media, to Recipient by Demodulation, provided such "Confidential Information" is marked as "Confidential Information. Confidential Information disclosed orally shall be identified as such in writing within five (5) days of disclosure. Nothing herein shall require Demodulation to disclose any of its information. For the avoidance of doubt, other than the specific glass fibers mentioned hereinabove, Demodulation shall not disclose to Recipient any information deemed confidential by Demodulation relating to the composition, design, and performance characteristics of the glass fibers and coatings therefor, processes for manufacturing such fibers and applying such coatings and the ultimate use of such fibers and coatings in particular applications. For example, Demodulation shall not disclose any information deemed confidential related to telecommunications optical fiber.

#### 2. Recipient's Obligations.

- A. Recipient agrees that the Confidential Information is to be considered confidential and proprietary to Demodulation and Recipient shall hold the same in confidence, shall not use the Confidential Information other than for the purposes of its business with Demodulation, and shall disclose it only to its officers, directors, or employees with a specific need to know. and to its contractors with a specific need to know, for similar purposes, who are subject to the obligations of 48 CFR 52.227-14(d)(2). Recipient, will not disclose, publish or otherwise reveal any of the Confidential Information received from Demodulation to any other party whatsoever, except to its contractors as specified above, except with the specific prior written authorization of Demodulation.
- B. Confidential Information furnished in recorded form shall not be duplicated by Recipient except for purposes of this Agreement. Upon the request of Demodulation, Recipient shall return all Confidential Information received in written or other recorded form, including copies, or reproductions or other recording media containing such Confidential Information, within ten (10) days of such request. At Recipient's option, any documents or other media developed by the Recipient containing Confidential Information may be destroyed by Recipient. Recipient shall provide a

written certificate to Demodulation regarding destruction within ten (10) days thereafter.

#### 3. Term.

The obligations of Recipient herein shall be effective 5 years from the date Demodulation last discloses any Confidential Information to Recipient pursuant to this Agreement.

#### 4. Other Information.

Recipient shall have no obligation under this Agreement with respect to Confidential Information which is or becomes publicly available without breach of this Agreement by Recipient; is or was rightfully received by Recipient without obligations of confidentiality; or is or was developed by Recipient without breach of this Agreement.

#### 5. Governing Law and Equitable Relief.

This Agreement shall be governed and construed in accordance with the laws of a court of competent jurisdiction.

#### 6. Final Agreement.

This Agreement terminates and supersedes all prior understanding or agreements on the subject matter hereof. This Agreement may be modified only by a further writing that is duly executed by both parties.

#### 7. No Assignment.

Recipient may not assign this Agreement or any interest herein, without Demodulation's express prior written consent.

#### 8. Severability.

If any term of this Agreement is held by a court of competent jurisdiction to be invalid or unenforceable, then this Agreement, including all of the remaining terms, will remain in full force and effect as if such invalid or unenforceable terms had never been included.

#### 9. Notices.

Any notice required by this Agreement or given in connection with it, shall be in writing and shall be given to the appropriate party by personal delivery or by certified mail, postage prepaid, or recognized overnight delivery services.

#### If to Demodulation:

Demodulation Inc. James E. O'Keefe, Jr. 121 Goodwin Terrace Westwood, NJ 07675

#### If to Recipient:

Insert Contractor Name National Nuclear Security Administration Contractor Address 10. No Implied Waiver.

Either party's failure to insist in any one or more instances upon strict performance by the other party of any of the terms of this Agreement shall not be construed as a waiver of any continuing or subsequent failure to perform or delay in performance of any term hereof.

11. Headings.

Headings used in this Agreement are provided for convenience only and shall not be used to construe meaning or intent.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date first above written.

Insert Contractor Name here	DEMODULATION INC.
By: <u>Mathalle Semanor</u>	By: James E. O'Keefe, Jr.
Title: Program Manger F	Title: President & CEO
Date: 6/16/05	Date: 4/14/05

# EXHIBIT C

# STEVENSON-WYDLER (15 USC 3710) COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (hereinafter "CRADA") No. Y-1207-0104\_

#### between

#### BWXT Y-12, L.L.C.

under its U.S. Department of Energy Contract No. DE-AC05-00OR22800 (hereinafter "Contractor")

and

#### DEMODULATION, INC.

(hereinafter "Participant"),

both being hereinafter jointly referred to as the "Parties"

for

# TARGETED ASSESSMENT DETECTION AND MONITORING (TADAM)

#### **ARTICLE I: DEFINITIONS**

- A. "Government" means the United States of America and agencies thereof.
- B. "DOE" means the Department of Energy, an agency of the United States of America.
- C. "Contracting Officer" means the DOE employee administering the Contractor's DOE contract.
- D. "Generated Information" means information produced in the performance of this CRADA.
- E. "Proprietary Information" means information which embodies (i) trade secrets or (ii) commercial or financial information which is privileged or confidential under the Freedom of Information Act (5 USC 552 (b)(4)), either of which is developed at private expense outside of this CRADA and which is marked as Proprietary Information.
- F. "Protected CRADA Information" means Generated Information which is marked as being Protected CRADA Information by a Party to this CRADA and which would have been Proprietary Information had it been obtained from a non-federal entity.
- G. Subject Invention means any invention of the Contractor or Participant conceived or first actually reduced to practice in the performance of work under this CRADA.
- H. "Intellectual Property" means Patents, Trademarks, Copyrights, Mask Works, Protected

Јалиату 25, 2007

CRADA Information and other forms of comparable property rights protected by Federal Law and other foreign counterparts.

- "Trademark" means a distinctive mark, symbol or emblem used in commerce by a producer or manufacturer to identify and distinguish its goods or services from those of others.
- J. "Service Mark" means a distinctive word, slogan, design, picture, symbol or any combination thereof, used in commerce by a person to identify and distinguish its services from those of others.
- K. "Mask Work" means a series of related images, however fixed or encoded, having or representing the predetermined, three-dimensional pattern of metallic, insulating or semiconductor material present or removed from the layers of a semiconductor chip product; and in which series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product. (17 USC 901(a)(2)).
- L. "RD&D" means research, development and demonstration performed by the Contractor and the Participant under this CRADA, including works performed by consultants or other contractors and subcontractors under this CRADA.
- M. "Background Intellectual Property" means the Intellectual Property rights in the items identified by the Parties in Appendix C, Background Intellectual Property, which were in existence prior to or are first produced outside of this CRADA, except that in the case of inventions in those identified items, the inventions must have been conceived outside of this CRADA and not first actually reduced to practice under this CRADA to qualify as Background Intellectual Property. Licensing of Background Intellectual Property, if agreed to by the Parties, shall be the subject of separate licensing agreements between the Parties. Background Inventions are not Subject Inventions.
- N. Foreign Interest is defined as any of the following:
  - (1) A foreign government or foreign government agency;
  - (2) Any form of business enterprise organized under the laws of any country other than the United States or its possessions;
  - (3) Any form of business enterprise organized or incorporated under the laws of the United States, or a State or other jurisdiction within the United States, which is owned, controlled, or influenced by a foreign government, agency, firm, corporation or person; or
  - (4) Any person who is not a U. S. citizen.
- O. Foreign ownership, control, or influence (FOCI) means the situation where the degree of ownership, control, or influence over a participant by a foreign interest is such that a reasonable basis exists for concluding that compromise of classified information or

special nuclear material, as defined in 10 CFR Part 710, may result.

## ARTICLE II: STATEMENT OF WORK

Appendix A, Statement of Work, is hereby incorporated into this CRADA by reference.

## ARTICLE III: TERM, FUNDING AND COSTS

- A. The effective date of this CRADA shall be the latter date of (1) the date on which it is signed by the last of the Parties or (2) the date on which it is approved by DOE. The work to be performed under this CRADA shall be completed within twenty-four (24) months from the effective date.
- B. The Participant's estimated contribution is \_\_\_\_\_\_ The Government's estimated contribution, which is provided through the Contractor's contract with DOE, is subject to available funding.
- C. Neither Party shall have an obligation to continue or complete performance of its work at a contribution in excess of its estimated contribution as contained in Article III B above, including any subsequent amendment.
- D. Each Party agrees to provide at least 60 days' notice to the other Party if the actual cost to complete performance will exceed its estimated cost.

## ARTICLE IV: PERSONAL PROPERTY

All tangible personal property produced or acquired under this CRADA (specifically excluding Intellectual Property rights, Background Intellectual Property, and Proprietary Information) shall become the property of the Participant or the Government, depending upon whose funds were used to obtain it. Such property is identified in Appendix A, Statement of Work. Personal property shall be disposed of as directed by the owner at the owner's expense. There shall not be any jointly funded property under this CRADA except by the mutual agreement of the Parties.

#### ARTICLE V: DISCLAIMER

THE GOVERNMENT, THE PARTICIPANT, AND THE CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE, OR DEVELOPED UNDER THIS CRADA, OR THE OWNERSHIP, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT. NEITHER THE GOVERNMENT, THE PARTICIPANT, NOR THE CONTRACTOR SHALL BE LIABLE FOR SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES ATTRIBUTED TO SUCH RESEARCH OR RESULTING PRODUCT, INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT

## ARTICLE VI: PRODUCT LIABILITY

Except for any liability resulting from any negligent acts or omissions of Contractor, Participant indemnifies the Government and the Contractor for all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the Participant, its assignees or licensees, which was derived from the work performed under this CRADA. In respect to this Article, neither the Government nor the Contractor shall be considered assignees or licensees of the Participant, as a result of reserved Government and Contractor rights. The indemnity set forth in this paragraph shall apply only if Participant shall have been informed as soon and as completely as practical by the Contractor and/or the Government of the action alleging such claim and shall have been given an opportunity, to the maximum extent afforded by applicable laws, rules, or regulations, to participate in and control its defense, and the Contractor and/or Government shall have provided all reasonably available information and reasonable assistance requested by Participant. No settlement for which Participant would be responsible shall be made without Participant's consent unless required by final decree of a court of competent jurisdiction.

# ARTICLE VII: OBLIGATIONS AS TO PROPRIETARY INFORMATION

- A. If Proprietary Information is orally disclosed to a Party, it shall be identified as such, orally, at the time of disclosure and confirmed in a written summary thereof, appropriately marked by the disclosing party, within ten (10) working days as being Proprietary Information.
- B. Each Party agrees to not disclose Proprietary Information provided by another Party to anyone other than the CRADA Participant and Contractor without written approval of the providing Party, except to Government employees who are subject to the statutory provisions against disclosure of confidential information set forth in the Trade Secrets Act (18USC 1905).
- C. All Proprietary Information shall be returned to the provider thereof at the conclusion of this CRADA at the provider's expense.
- D. All Proprietary Information shall be protected for a period of five (5) years from the date of execution of this CRADA, unless and until such Proprietary Information shall become publicly known without the fault of the recipient, shall come into recipient's possession without breach of any of the obligations set forth herein by the recipient, or shall be independently developed by recipient's employees who did not have access to such Proprietary Information.
- E. In no case shall the Contractor provide Proprietary Information of Participant to any person or entity for commercial purposes, unless otherwise agreed to in writing by such Participant.

# ARTICLE VIII: OBLIGATIONS AS TO PROTECTED CRADA INFORMATION

- A. Each Party may designate as Protected CRADA Information, as defined in Article I, any Generated Information produced by its employees and, with the agreement of the other Party, designate any Generated Information produced by the other Party's employees. All such designated Protected CRADA Information shall be appropriately marked.
- B. For a period of five (5) years from the date Protected CRADA Information is produced, Parties agree not to further disclose such Information except:
  - (1) as necessary to perform this CRADA;
  - (2) as provided in Article XI [REPORTS AND ABSTRACTS];
  - (3) as requested by the DOE Contracting Officer to be provided to other DOE facilities for use only at those DOE facilities with the same protection in place; or
  - (4) as mutually agreed by the Parties in advance, to comply with the requirements of reporting and filing Subject Inventions under Articles XIV and XVI.
- C. The obligations of (B) above shall end sooner for any Protected CRADA Information which shall become publicly known without fault of either Party, shall come into a Party's possession without breach by that Party of the obligations of (B) above, or shall be independently developed by a Party's employees who did not have access to the Protected CRADA Information.

# ARTICLE IX: RIGHTS IN GENERATED INFORMATION

The Parties agree that they shall have no obligations of non-disclosure or limitations on their use of, and the Government shall have unlimited rights in, all Generated Information, all Protected CRADA Information after the expiration of the period set forth in Article VIII (B) above and information provided to the Government or Contractor under this CRADA which is not marked as being copyrighted (subject to Article XIII) or as Protected CRADA Information (subject to Article VIII B) or Proprietary Information (subject to Article VII B), or which is an invention disclosure which may later be the subject of a U.S. or foreign patent application.

## ARTICLE X: EXPORT CONTROL

- A. THE PARTIES UNDERSTAND THAT MATERIALS AND INFORMATION RESULTING FROM THE PERFORMANCE OF THIS CRADA MAY BE SUBJECT TO EXPORT CONTROL LAWS AND THAT EACH PARTY IS RESPONSIBLE FOR ITS OWN COMPLIANCE WITH SUCH LAWS.
- B. The Participant has a continuing obligation to provide the Contractor written notice of any changes in the nature and extent of foreign ownership, control, or influence over the Participant which would affect the Participant's answers to the

previously completed FOCI certification.

# ARTICLE XI: REPORTS AND ABSTRACTS

- A. The Parties agree to produce the following deliverables:
  - an initial abstract suitable for public release at the time the CRADA is approved by DOE;
  - (2) other abstracts (final when work is complete, and others as substantial changes in scope and dollars occur);
  - (3) a final report, upon completion or termination of this CRADA, to include a list of subject inventions;
  - a semi-annual signed financial report of the Participant's in-kind contributions to the project;
  - other topical/periodic reports where the nature of research and magnitude of dollars justify; and
  - (6) computer software in source and executable object code format as defined within the Statement of Work or elsewhere within the CRADA documentation.
- B. It is understood that the Contractor has the responsibility to provide the above information at the time of its completion to the DOE Office of Scientific and Technical Information.
- C. Participant agrees to provide the above information to the Contractor to enable full compliance with paragraph B. of this Article.
- D. It is understood that the Contractor and the Department of Energy have a need to document the long-term economic benefit of the cooperative research being done under this agreement. Therefore, the Participant acknowledges a responsibility to respond to reasonable requests, during the term of this CRADA and for a period of two (2) years thereafter from the Contractor for pertinent information.

# ARTICLE XII: PRE-PUBLICATION REVIEW

- A. The Parties agree to secure pre-publication approval from each other which shall not be unreasonably withheld or denied beyond thirty (30) days.
- B. The Parties agree that neither will use the name of the other Party or its employees in any promotional activity, such as advertisements, with reference to any product or service resulting from this CRADA, without prior written approval of the other Party.

## ARTICLE XIII: COPYRIGHTS

- A. The Parties may assert copyright in any of their Generated Information. Assertion of copyright generally means to enforce or give any indication of an intent or right to enforce such as by marking or securing Federal registration.
- B. Each Party shall have the first option to retain ownership of copyrights in works created as Generated Information by its employees. Copyrights in jointly developed works shall be jointly owned. If either Party decides not to retain ownership of copyright in a work created by its employee(s), that Party agrees to assign such copyright to the other Party, at the other Party's request. Participant agrees to notify Contractor if it decides not to retain ownership of copyright in any work created by its employee(s); Contractor agrees to notify DOE if Participant or Contractor decide not to retain ownership of copyright in any work created by its employee(s). The Parties agree to assign to DOE, upon request, copyrights not retained by either Party.
- C. For Generated Information, the Parties acknowledge that the Government has for itself and others acting on its behalf, a royalty-free, non-transferable, non-exclusive, irrevocable worldwide copyright license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government, all copyrightable works produced in the performance of this CRADA, subject to the restrictions this CRADA places on publication of Proprietary Information and Protected CRADA Information.
- D. For all copyrighted computer software produced in the performance of this CRADA, the Party owning the copyright will provide the source code, an expanded abstract as described in Appendix B, the executable object code and the minimum support documentation needed by a competent user to understand and use the software to DOE's Energy Science and Technology Software Center, P.O. Box 1020, Oak Ridge, TN 37831. The expanded abstract will be treated in the same manner as Generated Information in paragraph C of this Article.
- E. The Contractor and the Participant agree that, with respect to any copyrighted computer software produced in the performance of this CRADA, DOE has the right, at the end of the period set forth in paragraph B of Article VIII hereof and at the end of each two-year interval thereafter, to request the Contractor and the Participant and any assignee or exclusive licensee of the copyrighted software to grant a non-exclusive, partially exclusive, or exclusive license to a responsible applicant upon terms that are reasonable under the circumstances, provided such grant does not cause a termination of any licensee's right to use the copyrighted computer software. If the Contractor or the Participant or any assignee or exclusive licensee refuses such request, the Contractor and the Participant agree that DOE has the right to grant the license if DOE determines that the Contractor, the Participant, assignee, or licensee has not made a satisfactory demonstration that it is actively pursuing commercialization of the copyrighted computer software.

Before requiring licensing under this paragraph E, DOE shall furnish the Contractor/Participant written notice of its intentions to require the Contractor/Participant

to grant the stated license, and the Contractor/Participant shall be allowed 30 days (or such longer period as may be authorized by the cognizant DOE Contracting Officer for good cause shown in writing by the Contractor/Participant) after such notice to show cause why the license should not be required to be granted.

The Contractor/Participant shall have the right to appeal the decision by the DOE to the grant of the stated license to the Invention Licensing Appeal Board as set forth in paragraphs (b)-(g) of 10 CFR 781.65, "Appeals".

F. The Parties agree to place Copyright and other notices, as appropriate for the protection of Copyright, in human readable form onto all physical media, and in digitally encoded form in the header of machine readable information recorded on such media such that the notice will appear in human readable form when the digital data are off loaded or the data are accessed for display or printout.

# ARTICLE XIV: REPORTING SUBJECT INVENTIONS

- A. The Parties agree to disclose to each other each and maintain in confidence every Subject Invention, which may be patentable or otherwise protectable under the Patent Act sufficient to preserve U.S. and foreign filing rights as necessary. The Parties acknowledge that the Contractor and Participant will disclose their respective Subject Inventions to the DOE within two (2) months after the inventor first discloses the Subject Invention in writing to the person(s) responsible for patent matters of the disclosing Party.
- B. These disclosures should be in sufficiently complete technical detail to convey a clear understanding, to the extent known at the time of the disclosure, of the nature, purpose and operation of the Subject Invention. The disclosure shall also identify any known actual or potential statutory bars, i.e., printed publications describing the Subject Invention or the public use or on sale of the Subject Invention in this country. The Parties further agree to disclose to each other any subsequent known actual or potential statutory bar that occurs for a Subject Invention disclosed but for which a patent application has not been filed. All Subject Invention disclosures shall be marked as confidential under 35 USC 205.

# ARTICLE XV: TITLE TO SUBJECT INVENTIONS

Whereas the Participant and the Contractor have been granted the right to elect to retain title to Subject Inventions:

A. Each Party shall have the first option to elect to retain title to any Subject Invention made by its employees. If a Party elects not to retain title to any Subject Invention of its employees, then the other Party shall have the second option to obtain title by assignment of such Subject Invention. The DOE shall retain title to any Subject Invention which is not retained by any Party. Each Party shall have the option to elect to retain title to its undivided rights in any Subject Invention made jointly by employees of Contractor and employees of Participant.

- B. The Parties acknowledge that the DOE may obtain title to each Subject Invention reported under Article XIV for which a patent application or applications are not filed pursuant to Article XVI and for which any issued patents are not maintained by any Party to this CRADA.
- C. The Parties acknowledge that the Government retains a nonexclusive, nontransferable, irrevocable, paid-up license to practice or to have practiced for or on behalf of the United States every Subject Invention throughout the world.
- D. For a period of 1) up to six (6) months from the date of filing of any patent applications by Contractor or 2) up to six (6) months from the date of completion or termination of the CRADA, whichever period expires first, Participant has an option to choose, for reasonable compensation, a Sole Commercial Patent License Agreement with Contractor for any patents or patent applications resulting from Subject Inventions made in whole or in part by employees of Contractor. Such Sole Commercial Patent License Agreement shall be in the field of use of "cell phone or critical asset class detection". The U. S Competitive Clause shall apply to all such agreements.

## ARTICLE XVI: FILING PATENT APPLICATIONS

- A. The Parties agree that the Party initially indicated as having an ownership interest in any Subject Inventions (Inventing Party) shall have the first opportunity to file U.S. and foreign patent applications. If the Contractor or Participant does not file such applications within one year after election, then the other Party to this CRADA exercising an option pursuant to Article XV may file patent applications on such Subject Inventions. If a patent application is filed by the other party (Filing Party), the Inventing Party shall reasonably cooperate and assist the Filing Party, at the Filing Party's expense, in executing a written assignment of the Subject Invention to the Filing Party and in otherwise perfecting the patent application, and the Filing Party shall have the right to control the prosecution of the patent application. The Parties shall agree between themselves as to who will file patent applications on any joint Subject Invention. The Parties shall share equally in the costs for the prosecution, filing and maintenance of joint Subject Inventions where both Parties elect to retain title to their undivided rights.
- B. The Parties agree that DOE has the right to file patent applications in any country if neither Party desires to file a patent application for any Subject Invention. Notification of such negative intent shall be made in writing to the DOE Contracting Officer within three (3) months of the decision of the non-inventing party to not file a patent application for the Subject Invention pursuant to Article XV or not later than 60 days prior to the time when any statutory bar might foreclose filing of a U.S. patent application.
- C. A Party electing title or filing a patent application in the United States or in any foreign country shall advise the other Party and the DOE if it no longer desires to continue prosecution, pay maintenance fees, or retain title in the United States or any foreign country. The other Party and then the DOE will be afforded the opportunity to take title and retain the patent rights in the United States or in any such foreign country.

D. Each Party agrees to provide the Project Manager of the other Party with a copy of each patent application it files on any Subject Invention.

#### ARTICLE XVII: TRADEMARKS

The Parties may seek to obtain Trademark/Service Mark protection on products or services generated under this agreement in the United States or foreign countries. The Parties hereby acknowledge that the Government shall have the right to indicate on any similar goods or services produced by or for the Government that such goods or services were derived from and are a DOE version of the goods or services protected by such Trademark/Service Mark with the Trademark and the owner thereof being specifically identified. In addition, the Government shall have the right to use such Trademark/Service Mark in print or communications media.

#### **ARTICLE XVIII: MASK WORKS**

The Parties may seek to obtain legal protection for Mask Works fixed in semiconductor products generated under this agreement as provided by Chapter 9 of Title 17 of the United States Code. The Parties hereby acknowledge that the Government or others acting on its behalf shall retain a non-exclusive, paid-up, worldwide, irrevocable, non-transferable license to reproduce, import, or distribute the covered semiconductor product by or on behalf of the Government, and to reproduce and use the Mask Work by or on behalf of the Government.

## ARTICLE XIX: COST OF INTELLECTUAL PROPERTY PROTECTION

Each Party shall be responsible for payment of all costs relating to Copyright, Trademark and Mask Work filing, U.S. and foreign patent application filing and prosecution, and all costs relating to maintenance fees for U.S. and foreign patents hereunder which are solely owned by that Party. Government/DOE laboratory funds contributed as DOE's cost share to a CRADA cannot be given to Participant for payment of Participant's costs of filing and maintaining patents or filing for Copyrights, Trademarks and Mask Works.

## ARTICLE XX: REPORTS OF INTELLECTUAL PROPERTY USE

Participant agrees to submit, for a period of two (2) years and upon request of DOE, a non-proprietary report no more frequently than annually on efforts to utilize any Intellectual Property arising under the CRADA.

#### ARTICLE XXI: DOE MARCH-IN RIGHTS

The Parties acknowledge that the DOE has certain march-in rights to any Subject Inventions in accordance with 48 CFR 27.304-1(g).

## ARTICLE XXII: U.S. COMPETITIVENESS

The Parties agree that a purpose of this CRADA is to provide substantial benefit to the U.S. economy.

In exchange for the benefits received under this CRADA, the Participant therefore agrees to the following:

- A. Products embodying Intellectual Property developed under this CRADA shall be substantially manufactured in the United States;
- B. Processes, services, and improvements thereof which are covered by Intellectual Property developed under this CRADA shall be incorporated into the Participant's manufacturing facilities in the United States either prior to or simultaneously with implementation outside the United States. Such processes, services, and improvements, when implemented outside the U.S., shall not result in reduction of the use of the same processes, services, or improvements in the United States; and
- C. The Contractor agrees to a U.S. Industrial Competitiveness clause in accordance with its prime contract with respect to any licensing and assignments of its intellectual property arising from this CRADA, except that any licensing or assignment of its intellectual property rights to the Participant shall be in accordance with the terms of Paragraphs A. and B. of this Article.

## ARTICLE XXIII: ASSIGNMENT OF PERSONNEL

- A. It is contemplated that each Party may assign personnel to the other Party's facility as part of this CRADA to participate in or observe the research to be performed under this CRADA. Such personnel assigned by the assigning Party shall not during the period of such assignments be considered employees of the receiving Party for any purposes.
- B. The receiving Party shall have the right to exercise routine administrative and technical supervisory control of the occupational activities of such personnel during the assignment period and shall have the right to approve the assignment of such personnel and/or to later request their removal by the assigning Party.
- C. The assigning Party shall bear any and all costs and expenses with regard to its personnel assigned to the receiving Party's facilities under this CRADA. The receiving Party shall bear facility costs of such assignments.

## ARTICLE XXIV: FORCE MAJEURE

No failure or omission by Contractor or Participant in the performance of any obligation under this CRADA shall be deemed a breach of this CRADA or create any liability if the same shall arise from any cause or causes beyond the control of Contractor or Participant, including but not limited to the following, which, for the purpose of this CRADA, shall be regarded as beyond the

#### CRADA Number Y-1207-0104

control of the Party in question: Acts of God, acts or omissions of any government or agency thereof, compliance with requirements, rules, regulations, or orders of any governmental authority or any office, department, agency, or instrumentality thereof, fire, storm, flood, earthquake, accident, acts of the public enemy, war, rebellion, insurrection, riot, sabotage, invasion, quarantine, restriction, transportation embargoes, or failures or delays in transportation.

# ARTICLE XXV: ADMINISTRATION OF THE CRADA

It is understood and agreed that this CRADA is entered into by the Contractor under the authority of its prime Contract with DOE. The Contractor is authorized to and will administer this CRADA in all respects unless otherwise specifically provided for herein. Administration of this CRADA may be transferred from the Contractor to DOE or its designee with notice of such transfer to the Participant, and the Contractor shall have no further responsibilities except for the confidentiality, use and/or non-disclosure obligations of this CRADA.

# ARTICLE XXVI: RECORDS AND ACCOUNTING FOR GOVERNMENT PROPERTY

The Participant shall maintain records of receipts, expenditures, and the disposition of all Government property in its custody related to the CRADA.

#### **ARTICLE XXVII: NOTICES**

- A. Any communications required by this CRADA, if given by postage prepaid first class U.S. Mail or other verifiable means addressed to the Party to receive the communication, shall be deemed made as of the day of receipt of such communication by the addressee, or on the date given if by verified facsimile. Address changes shall be given in accordance with this Article and shall be effective thereafter. All such communications, to be considered effective, shall include the number of this CRADA.
- B. The addresses, telephone numbers and facsimile numbers for the Parties are as follows:
  - 1. CONTRACTOR:
  - a. FORMAL NOTICES AND COMMUNICATIONS, COPIES OF REPORTS

Marilyn Giles
Manager, Office of Technology Transfer
Telephone: (865) 574-2214
Facsimile: (865) 241-4614

Email: gilesmh@y12.doe.gov

For Fedex, UPS, Freight: BWXT Y-12, L.L.C. Y-12 Plant, Bear Creek Road, Dock 47 Oak Ridge, TN 37830 For U. S. Mail Only: BWXT Y-12, L.L.C. P. O. Box 2009 Building 9737, MS 8091 Oak Ridge, TN 37831-8091

# b. TECHNICAL CONTACT, REPORTS, AND COPIES OF FORMAL NOTICES AND COMMUNICATIONS

Paul DeMint

Telephone: (865) 576-7418 Facsimile: (865) 576-7649 E-mail: demintpd@y12.doe.gov

For Fedex, UPS, Freight: BWXT Y-12, L.L.C. Y-12 Plant, Bear Creek Road Oak Ridge, TN 37830

For U. S. Mail Only: BWXT Y-12, L.L.C. P. O. Box 2009 Building 9202, MS 8204 Oak Ridge, TN 37831-8204

#### 2. PARTICIPANT

# a. TECHNICAL CONTACT, REPORTS, AND FORMAL NOTICES AND COMMUNICATIONS

Name: James E. O'Keefe, Jr.

President & CEO

Telephone: (201) 522-4720 Facsimile: (201) 666-0443

E-mail: jamesokeefe@optonline.net

For U. S. Mail, Fedex, UPS, Freight: Demodulation, Inc.

121 Goodwin Terrace Westwood, NJ 07675

#### ARTICLE XXVIII: DISPUTES

The Parties shall attempt to jointly resolve all disputes arising from this CRADA. If the Parties are unable to jointly resolve a dispute within a reasonable period of time, the dispute shall be

#### CRADA Number Y-1207-0104

decided by the DOE Contracting Officer, who shall reduce his/her decision to writing within 60 days of receiving in writing the request for a decision by either Party to this CRADA. The DOE Contracting Officer shall mail or otherwise furnish a copy of the decision to the Parties. The decision of the DOE Contracting Officer is final unless, within 120 days, the Participant brings an action for adjudication in a court of competent jurisdiction in the State of Tennessee. To the extent that there is no applicable U.S. Federal law, this CRADA and performance thereunder shall be governed by the law of the State of Tennessee.

#### **ARTICLE XXIX: ENTIRE CRADA AND MODIFICATIONS**

- A. It is expressly understood and agreed that this CRADA with its Appendices contains the entire agreement between the Parties with respect to the subject matter hereof and that all prior representations or agreements relating hereto have been merged into this document and are thus superseded in totality by this CRADA.
- B. Any agreement to materially change any terms or conditions of this CRADA or the Appendices shall be valid only if the change is made in writing, executed by the Parties hereto, and approved by DOE.

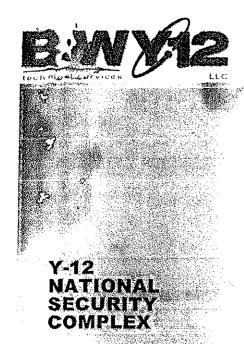
#### **ARTICLE XXX: TERMINATION**

This CRADA may be terminated by either Party upon thirty (30) days written notice to the other Party. This CRADA may also be terminated by the Contractor in the event of failure by the Participant to provide the necessary advance funding, as agreed in Article III.

In the event of termination by either Party, each Party shall be responsible for its share of the costs incurred through the effective date of termination, as well as its share of the costs incurred after the effective date of termination, and which are related to the termination. The confidentiality, use, and/or non-disclosure obligations of this CRADA shall survive any termination of this CRADA.

FOR CONTR	RACTOR, BWXT Y-12, LLC:
Ву:	
Name:	Willie Wilson
Title:	Senior Contracts Manager
Date:	12 FEB B7-
	•
FOR PARTIC	IPANT, Demodulation, Inc.:
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Z 3	James E. O'Keefe, Jr.
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# FINAL REPORT

Cooperative Research and Development Agreement (CRADA)

between

Demodulation Inc. and B&W Y-12 L.L.C.

Related to

# **Glass-Covered Amorphous Metal Microwires and Detection Systems**

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#### **ABSTRACT**

The Y-12 National Security Complex, a Department of Energy and National Nuclear Security Administration owned facility, managed and operated by B&W Y-12 L.L.C.; and Demodulation, Inc., located in Westwood New Jersey, recently concluded a two-year Cooperative Research and Development agreement. Demodulation provided glass-covered amorphous metal wire, detection equipment, and intellectual property to Y-12. Y-12 personnel performed numerous laboratory experiments in the applications areas of electronic article surveillance, tamper detection, *in-situ* sensors, and encoding techniques. Furthermore, personnel performed limited research into applications areas such as energy harvesting, near-field and far-field communications, and characterization of magnetic fields. For the foreseeable future, Y-12 personnel plan to continue development of in-situ sensors for condition monitoring purposes and for characterization of magnetic fields.

#### INTRODUCTION

The Y-12 National Security Complex, a Department of Energy (DOE) and National Nuclear Security Administration (NNSA) owned facility, managed and operated by B&W Y-12 L.L.C.; and Demodulation, Inc., located in Westwood New Jersey, recently concluded a two-year Cooperative Research and Development agreement (CRADA). Demodulation provided glass-covered amorphous metal wire, detection equipment, and intellectual property to Y-12. Y-12 personnel performed numerous laboratory experiments in the applications areas of electronic article surveillance, tamper detection, in-situ sensors, and encoding techniques. Furthermore, personnel performed limited research into applications areas such as energy harvesting, near-field and far-field communications, and characterization of magnetic fields.

Amorphous wire technology appears to be viable and suitable for many applications. There are numerous technical reports that have been published over the last twenty-five years that support this statement. Experiments conducted at Y-12 in FY2008 and FY2009 confirmed potential for the technology.

Demodulation provided a limited number of alloy compositions, none of which were explicitly tuned for a given application. It is evident from the research literature that slightly different alloy compositions can produce significant changes in responses.

Work was by the Control and Sensor Systems section of the Y-12 Applied Technologies Division, formerly known as the Development Division. A laboratory in the New Hope Center was used for the vast majority of the work, meetings, with the CRADA partner, and many tours and demonstrations of the technology. The New Hope Center is outside the security boundary of the Y-12 plant and offers an excellent venue for collaboration with private industry and academia.

From Y-12's perspective, the most promising application of amorphous wire technology is in the area of *in situ* sensors. Gas, pressure, temperature, humidity, and position sensors are in various state of development with the (partial pressure) gas sensor being the farthest along. These sensors have the capability of being embedded in non-magnetic items, they are passive (no battery required for energy), and they are wireless (no wires needed for data acquisition). Challenges remain in increasing stand-off detection distance; however, in some cases, adequate stand-off distance is already viable.

Another application area that is promising is in encoding information. Most people have had credit/debit cards or identification badges that must be replaced when the magnetic strip wears out. It may be possible to have many amorphous wires embedded in the card/badge itself in such a way as to represent the information. This technique would also serve as an excellent anti-counterfeiting solution.

For the foreseeable future, Y-12 personnel plan to continue development of in-situ sensors for condition monitoring purposes and for characterization of magnetic fields.

In context of cost and simplicity of the technological process, the glass-covered wires have a great advantage over those produced by the in-water spinning method.<sup>3</sup>

There are almost an unlimited number of potential alloy compositions. Y-12 experimented with two basic compositions: a Cobalt (Co) based composition with Iron (Fe), Silicon (Si), and Boron (B), (CoFeSiB); and a Iron (Fe) based composition with Silicon (Si) and Boron (B) (FeSiB). The magnetic properties of amorphous glass covered wires are strongly influenced by their chemical composition.<sup>4</sup>

In addition to amorphous wire, there are also amorphous ribbons. There appear to be two major manufacturing firms; Metglas®<sup>5</sup> of Conway S.C., a Hitachi (Japan) company, and Vacuumschmelze<sup>6</sup> (Germany). Amorphous ribbons are found in tags used for Electronic Article Surveillance systems. Both companies also make amorphous materials for highly efficient electrical voltage transformers.

Research in amorphous materials also led to development of similar types of materials with unique characteristics. One such example is Terfenol, a material with unique magnetostriction characteristics. The Naval Ordnance Labs, now known as Naval Surface Warfare Center - Carderock Division (NSWC-CD), developed the material in the 1970's and the manufacturing process was perfected in the 1980's at the Ames Laboratory with U.S. Navy funding. ETREMA (Ames, IA) holds patents and licenses to many Terfenol-D applications, including the exclusive worldwide licenses to manufacture all types of Terfenol-D materials. Another example is Vitreloy®, an amorphous material with high yield strength and other advantageous structural properties. Vitreloy® was developed at the California Institute of Technology with funding from the Department of Energy (DOE) and National Aeronautic and Space Administration (NASA). LiquidMetal® Technologies has exclusive licenses to the Vitreloy alloys and market them under the LiquidMetal® trade name.

Patents held or licensed by Demodulation Inc. are listed in Appendix A. Documents and presentations created by Y-12 personnel are listed in Appendix B. Considerable research has been performed on amorphous wires over the last twenty-five years, primarily from foreign institutions. A sample listing of the literature available can be found in Appendix C.

<sup>&</sup>lt;sup>3</sup> D. P. Makhnovskiy and L. V. Panina, Field Stress-Tunable Microwave Composite Materials, page 261, Ferromagnetism Research, V. N. Murray, Editor, Nova-Science Publishers, Inc., 2006.

<sup>&</sup>lt;sup>4</sup> Chiriac, H., Ovari, T.A., Amorphous Glass-Covered Magnetic Wires, Progress in Materials Science, p. 395, 1996.

<sup>&</sup>lt;sup>5</sup> Metglas®, http://www.metglas.com/

<sup>&</sup>lt;sup>6</sup> Vacuumschmelze. http://www.vacuumschmelze.de/dynamic/en/

<sup>&</sup>lt;sup>7</sup> Terfenol-D, from Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Terfenol-D

<sup>8</sup> ETREMA Products, Inc. http://www.etrema-usa.com/

<sup>&</sup>lt;sup>9</sup> Vitreloy, from Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Vitreloy

<sup>&</sup>lt;sup>10</sup> LiquidMetal® Technologies. http://www.liquidmetal.com/index/default.asp

#### **WORK PERFORMED**

The CRADA originally had two objectives; (1) Development of a Cell-Phone Detection System and (2) Demonstration of a Tamper Detection System. Other activities performed during the CRADA involved studies involving, but not limited to, *in-situ* sensors, energy harvesting, encoding techniques, near-field communications, detector stand-off distances, and signal analysis.

## Development of a Cell-Phone Detection System

At the time of the CRADA initiation, detecting non-government cell-phones entering the Y-12 National Security Complex was receiving a considerable amount of attention from the DOE/NNSA and Y-12 senior management. As for Demodulation, such a system could become the basis for an Electronic Article Surveillance (EAS) system applicable in the commercial environment.

Two different compositions of wire were used. Detection of the microwire within a magnetic field via the RF detection scheme was a total success, however, one composition performed much better than the other one. However, when the microwire was attached to some cell phones, particularly when the cell phone casing had a metal-like coating, it was difficult to detect the wire. It was during the early stages of conceptual design of a robust system that Y-12 personnel had to re-evaluate the priorities of the CRADA. To have a useful cell-phone detection system at Y-12, detection systems would need to be deployed at the existing security portals. Most security portals are outside and must be protected against the environment. Furthermore, since all security portals are under formal "change control" procedures, any and all, modifications and/or additions to the portals would take an extensive review and approval process requiring detailed documentation and testing. A preliminary cost estimate indicated that funding for deployment would be unlikely. At that point, Y-12 researchers indicated a reluctance to spend the remainder of FY08 funding on designing, fabricating, and testing a robust system that would not be deployed at Y-12.

It needs to be stated that EAS systems based on amorphous microwire can be designed and deployed at a reasonable cost and with high success rates. However, there are some scenarios for EAS systems that would require an extremely robust design.

# Tamper Detection

Tamper Detection is another application that has benefit to government and commercial interests. At Y-12, tamper indication devices (TID) are used with containers that contain high value material. In the commercial world, "tamper indication" has been a priority for companies ever since the 1982 Chicago Tylenol murders. Complementary to a tamper detection application is the anti-counterfeiting application. In fact, in some cases the easiest way to defeat a TID is to simply counterfeit a replacement.

Glass-covered amorphous wires are an excellent technology for addressing tamper detection and counterfeiting. The most desirable features are their ability to be concealed/embedded, passive, and wireless. Many experiments were conducted which concluded the technology is viable.

There are several ways to determine a tampered wire. First, one can distinguish between wires of different lengths. For certain scenarios, a tamper indicating device (TID) can be configured to break a wire into two or more pieces. Detection of a wire is dependent on exceeding a minimum length using the RF detection technique. A different type of response, but just as effective, is indicated by using the magnetic pick-up technique.

A second way is devising a configuration that would change the tension on a wire. For wire compositions that are sensitive to stress, there is a linear relationship between response and the tension on a wire. This linear relationship exists for a workable range of values. Experiments demonstrated that for certain compositions of wire, 0.2 grams of change in tension can be detected.

A third way to determine tampering is by change in orientation of the wire. The response from a wire, with either detection method, is a function of the angle of the magnetic field vector and the longitudinal axis of the wire.

There are numerous other ways to configure a wire for a TID and/or anti counterfeiting application. However breakage, change-in-tension, and/or change-in-orientation are the most plausible configurations.

It was also of prime importance to demonstrate a form factor for a detection scheme that was clearly portable. For the RF detection scheme, a portable version was not fabricated due to costs and schedule constraints. However, a portable detection system incorporating the magnetic pick-up scheme was fabricated. The unit was fabricated using the casing and reels from a VHS cassette. The unit was connected to a sound card in a laptop. Although the stand-off range was only around one inch, it demonstrated the desired form factor and produced reliable results.

Three different compositions of wire were used during tamper detection experiments. All produced effective, but different, responses.

Y/DX-2791, "Characterization and Testing of Amorphous Microwire Using Magnetic and Radio Frequency Detection Schemes", was published in October 2008 and provides technical information about theory and experimental results. The Executive Summary of the document is unclassified, non-sensitive and is available for public release. The complete document is marked Protected CRADA Information.

#### In-situ Sensors

The amorphous wire can be embedded in non-magnetic items. Certain compositions are sensitive to stress, or change-in-tension. They are passive and do not require a battery. They are wireless; for data acquisition, they are interrogated by an external system. These attributes make amorphous wire excellent candidates for *in-situ* sensors.

With funds available after abandoning a robust design for cell phone detection and/or an EAS, there was focus on designing *in-situ* sensors. From a government point of view, there has been considerable interest in such sensors since the early 1990's. From a commercial point of view, there are few competing products. Whereas there are commercial companies entrenched in the EAS and tamper indication markets, the market for *in-situ* sensors appears to be open, uncontested, and available for exploitation.

Gas, pressure, temperature, humidity, and position sensors are in various stages of development at Y-12. All have been or will be tested in a closed stainless steel vessel. The stainless steel vessel can be evacuated or pressurized with a variety of gases and temperature cycled. At this time, a gas sensor is the farthest along in development. All of the sensors work on the same fundamental principle; a change in tension of the wire can be detected with precision and repeatability. For many of the sensors, the amorphous wire is attached to another component that changes the tension in the wire.

For example, for detection of a given gas, a commercially available component was procured that changes length when subjected to a relatively small partial pressure of a gas. The amorphous wire is fixed at two locations on the component. When the component changes length, a stress is induced in the amorphous wire. Y/DX-2869, "Gas Sensor for Condition Monitoring", was published in October 2009 and describes in detail the configuration, theory, and experimental results. The report is marked Protected CRADA Information.

Another example is the pressure sensor. In this configuration an amorphous wire is fixed to one end of a sealed bellows that expands and contracts as a function of the difference of pressure inside the sealed bellows and the pressure inside the stainless steel vessel. The expansion and contraction changes the tension on the amorphous wire. A detailed report on the pressure sensor should be available in 2010.

Technical work in FY2010 will address increasing the stand-off distance between the embedded sensor, sensor optimization, and the detection hardware. Previous work predicts this may be very challenging and may limit the number of applications this technology can be used. However, there could be an alloy composition that would be more effective than that used and which could possibly minimize the challenges.

#### **Other Studies**

A limited amount of effort went into investigating the potential for **energy harvesting**. It was concluded that a single 40 micron diameter wire may have a few micro-watts of energy stored during magnetic domain switching. Configuring many (hundreds to thousands) wires together

may provide hundreds of milliwatts comparable to published research that utilized amorphous metal ribbons. Due to commercially available products that address energy harvesting on this scale, further research by Y-12 is not warranted at this time.

Due to the dependency on the frequency and strength of the magnetic field for response from the wire; a limited amount of effort went into the potential for **near-field** (less than 1 meter) and **far-field communications**. It was concluded that although unique systems could be developed for communications, there are basic barriers in using an amorphous wire systems within the ISO/IEC and ECMA standards. For example, All Near Field Communication transponders must be able to operate within a magnetic field strength of 1.5 to 7.5 A/m RMS; for alloy compositions tested, the amorphous wire needs 4.5 A/m to be detected. In addition, sampling rates would need to accommodate a maximum data rate of 848 kb/second. At this time, those rates are not achievable with Y-12's current laboratory configurations.

Research was also conducted in creating and reading multi-bit identification tags. The tag was comprised of parallel lengths of amorphous wire of identical alloy composition, but they could have different lengths. The identification tag is read by applying a ramped or AC magnetic field while simultaneously applying a DC bias field that was created with novel coil geometry. The main advantage of using amorphous wire versus the magnetic strips found on credit cards and other such items is concealment and length of service. Magnetic strips wear out, there should no degradation of amorphous wires since they can be embedded with the card. This technique could also be useful for certain anti-counterfeiting applications.

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#### CONCLUSIONS

Amorphous metal wire technology, using Iron (Fe) and Cobalt (Co) based alloys, appear to be a viable technology. Considerable research has been performed and published world-wide over the last twenty-five years that support this conclusion. It is also evident that, even with an abundant source of high-quality research material, a non-trivial amount of engineering is required to develop prototypes that function properly and are cost-effective outside of a laboratory environment.

Amorphous wire technology can be used in a number of different application areas. However, in certain application areas, markets have already been established and a robust supply and value chain is in place. The best example of this is in the area of Electronic Article Surveillance (EAS). Another example is the magnetic strip technology used on credit/debit cards, identification badges, and such. In other application areas there may not be a robust value chain in place, however, there are a wide variety of commercial products, and technologies, that compete with each other. For example, in energy harvesting/scavenging there are solar cells, thermoelectric modules, and piezoelectric elements that can harvest energy from the environment and produce energy on the same scale as a few hundred amorphous wires. Amorphous wire technology may not be "disruptive" or "game-changing" enough to supplant those firmly entrenched technologies.

However, the "greenfield" appears to be in the application area of sensors; in particular, *in-situ* sensors. There are few, if any, commercial sensors that can be embedded, and are passive and wireless. Gas, pressure, temperature, and humidity sensors, just to name a few, appear to be viable from a cost, quality, and performance perspective. A challenge, in some cases, will be the stand-off distance between the sensor and the detection hardware.

## Appendix A: Intellectual Property of Demodulation, Inc.

This appendix covers intellectual property of Demodulation, Inc. "Demodulation Inc. enjoys an exclusive worldwide license from its assignee, the National Institute for Research and Development of Technical Physics (NIRDTP) in Iasi, Romania," under the patents a through c. Items b and c are "European patents that have been registered and maintained in 37 countries." Patents a through c "provide broad coverage for the compositions and processes used to produce glass-coated microwire having highly advantageous properties." Items d through I "identify United States patents covering detection methods and systems, as well as encoding methods related to detecting and identifying objects remotely." Items m through s "identify published patent applications, which strengthen and extend the core patents listed above and are at stages of prosecution near issuance." "I

US 6,270,591 B2—Amorphous and Nanocrystalline Glass-Covered Wires

EP0870308—Amorphous Magnetic Glass-Covered Wires and Process for Their Production

EP1288972—Nanocrystalline Magnetic Glass-Covered Wires and Process for Their Production

US 6,018,297—Method and Device for Coding Electronic Labels

US 6,232,879—Sensor and Method for Remote Detection of Objects

US 6,137,411—Article Surveillance System

US 6,225,905—Sensor for Remote Detection of Objects

US 6,417,771—Sensor, a Method and a System for Remote Detection of Objects

US 5,739,752—Method In Detecting Magnetic Elements

US 5,551,158—Method for Measuring Position and Angle

US 5,557,085—Method and Device for Electronic Identification

US 5,576,693—Method and Device for Remote Sensing of Objects

US 20040070502—Marker for Remote Detection of Articles

Number: 20050158545—Engineered Glasses for Metallic Glass-Coated Wire

Number: 20050000599—Amorphous and Nanocrystalline Glass-Coated Articles

Number: 20050109435—Multi-Bit Encoded Glass-Coated Microwire and Articles Composed Thereof

Number: 20050221365—Polymerase Chain Reaction Using Metallic Glass-Coated Microwire

Number: 20050237197—Detection of Articles Having Substantially Rectangular Cross-Sections

Number: 20060086528—Optically Encoded Glass-Coated Microwire

Earnest D. Buff of Ernest D. Buff & Associates in Bedminster, NJ letter to Robert Iszard, Project Manager at Empire State Department, Buffalo, NY detailing intellectual property of Demodulation, Inc., August 6, 2006.

### Appendix B: Articles and Reports prepared by Y-12

Y-DX-2791, "Characterization and Testing of Amorphous Microwire Using Magnetic and Radio Frequency Detection Schemes", was published in October 2008 and describes work performed in fiscal year 2008. This report contains Protected CRADA Information. The Executive Summary, Y/DX-2791 Executive Summary, is unclassified, non-sensitive; and is available for public release.

"CRADA Team's Microwire Signals an Array of Applications", published in the August 2009 issue of The Federal Laboratory Consortium for Technology Transfer (FLC). The link to the article is at <a href="http://www.federallabs.org/news/top-stories/articles/2pt=top-stories/articles/0809-01.jsp">http://www.federallabs.org/news/top-stories/articles/2pt=top-stories/articles/0809-01.jsp</a>.

Y/DX-2869, "Sensor for Condition Monitoring", was published in October 2009 and describes work performed in fiscal year 2009 on an *in-situ* sensor. This report contains Protected CRADA Information.

### **Appendix C: Selected Reference Papers**

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Hundreds, if not thousands, of papers, describing amorphous wires and their applications, are available. Listed below is a representative sample of such publications

Chiriac H, Ovari TA, "Amorphous glass-covered magnetic wires: Preparation, properties, applications", PROG MATER SCI 40 (5): 333-407, 1996.

- J. R. Petta, M. B. Weissman and G. Durin, "Dependence of Barkhausen pattern reproducibility on hysteresis loop size," The American Physical Society, Vol 56, No. 3, pp. 2776–2780, September 1997.
- C. A. Grimes et al., "Wireless Magnetoelastic Resonance Sensors: A Critical Review," Sensors 2002, 2, pp. 294–313.
- C. A. Grimes et al., "Magnetoelastic sensors in combination with nanometer-scale honeycombed thin film ceramic TiO2 for remote query measurement of humidity," J. Appl. Phys., Vol. 87, No.9, 1 May 2000.
- E. E. Mitchell, R. DeMoyer and J. Vranish, "A New Metglas Sensor," IEEE Transactions on Industrial Electronics, Vol. IE-33, No. 2, May 1986, pp. 166–170.
- M. Han, D. F. Liang, L. J. Deng, "Sensors development using unusual properties of Fe/Co-based amorphous soft magnetic wire", Journal of Material Science, 25 August 2005.

Richard R. Fletcher and Neil A. Gershenfeld, "Remotely Interrogated Temperature Sensors Based on Magnetic Materials", IEEE Transactions on Magnetics, VOL. 36, NO. 5, September 2000.

"Progress in Ferromagnetism Research", V. N. Murray, Editor, NOVA Publishers, March 2006.

Serghei Sandacci, Dmitriy Makhnovskiy, Larissa Panina, and Vladimir Larin; "Stress-Dependent Magnetoimpedance in Co-Based Amorphous Wires and Application to Tunable Microwave Composites", IEEE Xplore Digital Library, April 2005.